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CULTURES OF HETEROECIOUS RUSTS IN 1918

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While making a field survey in western Canada of the rusts which attack cereals, a number of grass and sedge rusts were collected, and a few cultures which field observations suggested were undertaken. These cultures were carried on in a well-lighted room in the Dominion Laboratory at Brandon, Man.

The methods of inoculation were those commonly employed. When teliosporic material was used it was placed in a moist chamber until the teliospores were germinating, when it was suspended above the plants used in the cultures. The plants and teliosporic material were then sprayed with water by means of an atomizer and covered with a bell jar for about 48 hours. When aeciosporic material was used the fresh aeciospores were transferred with a flat needle to the leaves of the culture plants and in addition the parts bearing aecia were suspended above so that the aeciospores would fall on the plants used in the culture. They were then sprayed and covered with a bell jar as in the case of the teliosporic experiments. Checks were kept which in all cases remained free from infection.

UROMYCES ALOPECURI Seym.

Aecia on *Ranunculus Macounii* Britton were often found associated with this rust on *Alopecurus aristulatus* Michx., so that the connection of the aecia was clearly indicated. On June 16th, two pots of *Alopecurus aristulatus* and one each of *Agropyron tenerum* Vasey and *Hordeum jubatum* L. were inoculated with fresh aeciospores collected at Brandon, Man. Uredinia began to appear on the pots of *Alopecurus* on June 23, and eventually aeciospores developed abundantly, followed later by telia. There was no infection of the other grasses. Collections of aecia were

also made on *Ranunculus sceleratus* L. in the vicinity of the rusted *Alopecurus* which doubtless belong here.

Orton (Mycol. 4: 194. 1912) discusses the correlation between certain species of *Puccinia* and *Uromyces* and gives a number of examples of correlated species. *Uromyces Alopecurus* is clearly correlated with *Puccinia perplexans* Plow. (now usually placed with *Puccinia Agropyri* E. & E.) on *Alopecurus pratensis* L. Cultures by the writer (Mycol. 4: 179. 1912) showed that *Puccinia perplexans* has aecia on *Ranunculus acris* L.

Puccinia angustata Peck

Observations in the field clearly indicated that aecia on *Mentha canadensis* L. were connected with a rust on *Scirpus atrovirens* Muhl. Viable teliosporic material was collected at Brandon in the spring and two pots of *Mentha canadensis* were inoculated on May 28. Pycnia became evident on June 3 and aecia on June 10, infection being very abundant. Dr. Arthur determined the rust as *Puccinia angustata* Peck and pointed out that the aecia had been confused with the aecia of *Puccinia Menthae* Pers. notwithstanding they are much smaller and paler in color. Collections of aecia on *Mentha canadensis* belonging to this species were made later in the season at Dauphin, Man., where they were quite common.

Dr. Arthur has shown many times that this rust also has aecia on *Lycopus* (Bot. Gaz. 35: 15, 21. 1903. Jour. Mycol. 8: 53, 54. 1902, 11: 58. 1905; 12: 15. 1906; 14: 13. 1908. Mycol. 1: 223. 1909; 2: 224. 1910; 4: 54. 1912; 7: 70. 1915). This experiment, however, establishes for the first time connection with aecia on *Mentha*.

Puccinia phragmitis (Schum.) Koern.

This rust was collected on *Phragmites communis* Trin. at Dauphin, Man. Wintered teliosporic material gave excellent germination and inoculations were made on plants of *Rumex*. Pycnia and aecia developed in abundance. The species of *Rumex* used in the culture could not be determined but it probably was *R. occidentalis* Wats. Collections of aecia were made

on *Rumex occidentalis* Wats. and *R. mexicanus* Meisn. in the field in the vicinity of the rusted *Phragmites* which belong to this species. Dr. Arthur (Bot. Gaz. 29: 269. 1909. Jour. Mycol. 9: 220. 1903; 14: 15. 1908. Mycol. 2: 225. 1910; 4: 54. 1912) has conducted several successful cultures with this species.

PUCCINIA IMPATIENTIS (Schw.) Arth.

Aecia were found abundantly on *Impatiens biflora* Walt. at Dauphin, Man., and field evidence strongly suggested their connection with a rust on *Hordeum jubatum* L. On July 15 three pots of *Hordeum jubatum* and one of *Triticum vulgare* L. were inoculated with fresh aeciospores. Uredinia were noticed on all the pots of *Hordeum jubatum* on July 25 and an abundant development of urediniospores followed. Telia began to form on August 2. The leaves of wheat flecked but there was no development of uredinia.

Further study is necessary to determine the systematic position of this rust, but it seems best for the present to place it with *Puccinia impatientis* which Arthur (Bot. Gaz. 35. 18. 1903. Jour. Mycol. 10: 11. 1904; 11: 57. 1905. Mycol. 2: 226. 1910) has shown to have aecia on *Impatiens* and telia on *Elymus*. It is very common on *Hordeum jubatum* in northern Manitoba.

PUCCINIA AGROPYRI E. & E.

In the vicinity of Brandon in many places aecia were common on species of *Thalictrum*. Field evidence indicated very strongly their connection with a sub-epidermal rust on *Bromus ciliatus* L. and *B. latiglumis* (Shear) Hitchc. There was also some evidence of connection with *Puccinia Agropyri* E. & E. on species of *Elymus* and *Agropyron*. On June 18 inoculations were made with aeciospores from *Thalictrum dasycarpum* Fisch. & All. collected at Brandon on the following grasses: *Elymus canadensis* L., *E. virginicus* L., *Agropyron tenerum* Vasey, *A. Richardsonii* Schrad., *Hordeum jubatum* L. and *Triticum vulgare* L. Uredinia appeared on *E. canadensis* on June 30, followed by telia on July 20. On *E. virginicus* uredinia were noticed on June 28 and telia by

July 11. *Hordeum jubatum* showed a slight infection, uredinia appearing on July 3, but telia were not formed, the plants not being healthy. There was no infection of the other grasses. On June 24, *Bromus ciliatus* was inoculated and uredinia were noticed on July 3 and telia by July 8, both were produced in great abundance.

Examination showed the rust on *Bromus*, both the field and culture collections, to possess teliospores very variable in size, shape and number of cells, only rarely could two-celled spores of the *Puccinia* type be found, practically all of the spores being three to several celled, some having as many as sixteen cells. The teliospores on *Elymus* were typical of *Puccinia Agropyri*, both those developed from the culture and field collections, though a few were three or more celled.

As Long (Jour. Agr. Res. 2: 303. 1914) has shown that the host plant affects the morphological character of the spores in *Puccinia Ellisiana* Thuem. it was thought possible that the rust on *Bromus* and *Elymus* might be identical though showing such marked morphological differences in the teliospores. To test this, inoculations were made with the urediniospores from the culture on *Bromus ciliatus* on the following grasses: *Elymus virginicus* L., *Agropyron tenerum* Vasey, *A. Smithii* Rydb., *A. repens* (L.) Beauv. and *Hordeum jubatum* L. There was no infection of any of the grasses so it seems probable that the form of *Bromus* is biologically distinct, and that the plants of *Thalictrum* used in the culture bore two kinds or strains of aecia, one capable of infecting *Bromus* and another which infected *Elymus*, *Agropyron* and *Hordeum*.

Trelease (Jour. Mycol. 1: 14. 1885) described a subepidermal rust on *Bromus* as *Puccinia tomipara* Trel. on account of some of the teliospores being three to several celled. Lagerheim placed this species in the genus *Rostrupia* on account of the several celled teliospores. Arthur (Mycol. 7: 74. 1915) regards the group of subepidermal forms passing under various names with telia chiefly on *Agropyron*, *Elymus* and *Bromus* and aecia on Ranunculaceous hosts as forming one species. This includes *Puccinia tomipara* Trel.

The marked morphological departure from the *Puccinia* type by the teliospores of the *Bromus* rust used in the culture, make it doubtful whether it should be included in the genus *Puccinia*. The character seems fixed as many collections made at Brandon showed this character, as well as collections made on *Bromus latiglumis* (Shear) Hitchc. at Brandon, and Morris, Man. As its other characters and life cycle show a close relation with *Puccinia Agropyri*, it seems best to include it here until further study determines its true position.

SUMMARY

Uromyces Alopecuri Seym. Aeciospores from *Ranunculus Macounii* Britton infected *Alopecurus aristulatus* Michx.

Puccinia angustata Peck. Teliospores from *Scirpus atrovirens* Muhl. infected *Mentha canadensis* L.

Puccinia Impatiensis (Schw.) Arth. Aeciospores from *Impatiens biflora* Walt. infected *Hordeum jubatum* L.

Puccinia Phragmitis (Schum.) Koern. Teliospores from *Phragmitis communis* Trin. infected *Rumex* Sp.

Puccinia Agropyri E. & E. Aeciospores from *Thalictrum dasycarpum* Fisch. & All. infected *Elymus canadensis* L., *E. virginicus* L., *Hordeum jubatum* L. and *Bromus ciliatus* L. Uredospores from *Bromus ciliatus* L. failed to infect *Elymus virginicus* L., *Agropyron Smithii* Rydb., *A. tenerum* Vasey, *A. repens* (L.) Beauv. and *Hordeum jubatum* L.

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